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TECHNICAL REPORT
NATICK/TR-92/005

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TECHNICAL OBJECTIVE DOCUMENT FOR COMBAT CLOTHING, UNIFORMS AND INTEGRATED PROTECTIVE SYSTEMS

By
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November 1991

FINAL REPORT
May 1988 - November 1991

Prepared for
UNITED STATES ARMY NATICK
RESEARCH, DEVELOPMENT AND ENGINEERING CENTER
NATICK, MASSACHUSETTS 01760-5000

INDIVIDUAL PROTECTION DIRECTORATE

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This document provides information on the Army's technical objectives for the Combat Clothing, Uniforms, and Integrated Protective Systems areas to the external community, both Government and nongovernment, including academic, scientific, and industrial organizations. Its purpose is to stimulate the participation of such organizations in Army research and development. Areas include:

Management Review
Technology Base Investment Strategy
Progress and Accomplishments
Planned Programs (Research, Technology and Development)
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SUMMARY

This document provides information on the Army's technical objectives for the Combat Clothing, Uniforms and Integrated Protective Equipment areas to the external community, both Government and nongovernment, including academic, scientific and industrial organizations. Its purpose is to stimulate the participation of such organizations in Army research and development.

Areas covered include:

- Management Review
- Technology Base Investment Strategy
- Progress and Accomplishments
- Planned Programs (research, development, and engineering)
- Major Technological Barriers
- Program Relationships and Interactions

I. INTRODUCTION

The U.S. Army Technical Objective Document is an important part of the Army's Information for Industry Program. Each Army laboratory and research, development and engineering center has an opportunity annually to prepare a Technical Objective Document based upon Army requirements, scientific and technological opportunities, and the needs of present and projected systems.

We all recognize that the developments and accomplishments of the Army are the product of teamwork among Army scientists and engineers and their counterparts in industry and the academic community. This document is intended to increase this teamwork by providing you with necessary information on our research, development and acquisition program. Specific objectives are:

> To provide planning information for independent research and development programs.
>
> To improve the quality of unsolicited proposals and Research and Development (R&D) procurements.
>
> To encourage face-to-face discussions between Army engineers and scientists and their external counterparts.

As you read through the pages that follow, you may see an opportunity to which your organization can respond. We invite you to discuss the opportunity with the scientist or engineer identified therein. Furthermore, you may have completely new ideas not considered in this document which, if brought to the attention of the proper organization, could make a significant contribution to the Army's capabilities. The Army has a continuing interest in receiving proposals that contain new ideas, suggestions and innovative concepts for weapons, supplies, facilities, devices and equipment. In other words, your ideas, whether in response to this document or not, are always welcome.

Classified/limited Technical Objective Documents are available from the Defense Technical Information Center (DTIC), as are unclassified/unlimited documents. These documents, as well as additional information on doing business with the Army, are also available from the Army's Technical and Industrial Liaison Offices.

II. MANAGEMENT OVERVIEW

1. MISSION

The mission of the U.S. Army Natick Research, Development and Engineering Center (Natick) is to ensure maximum survivability, supportability, sustainability, and combat effectiveness of individual soldiers and crews on the battlefield under worldwide environmental extremes.

Our goal is to provide the American soldier the best equipment for the best price through research, development and engineering in the areas of Airdrop Systems, Food and Food Service Systems, Tactical Shelters, and Clothing and Individual Equipment. We are deeply committed to making our soldiers, and all service members, the best equipped and best fed in the world.

2. ORGANIZATIONAL STRUCTURE

Natick is an element of the U. S. Army Troop Support Command (TROSCOM), a major subordinate command of the U.S. Army Materiel Command (AMC). We are currently organized into five mission-oriented directorates - the Individual Protection Directorate (IPD), the Food Engineering Directorate (FED), the Aero-Mechanical Engineering Directorate (AMED), the Advanced Systems Directorate (ASD), the Soldier Science Directorate (SSD), - and requisite administrative support elements.

Our commodity directorates are responsible for planning, organizing and overseeing the conduct of all required research, development, and engineering in their assigned areas. IPD performs these functions for CLOTHING AND INDIVIDUAL EQUIPMENT and also coordinates all Army-contributing RD&E efforts concerned with the protection of the individual soldier.

3. PROGRAM AREAS

Natick's programs encompass the total spectrum of research, exploratory, advanced and full-scale engineering development, and the operations and maintenance activities essential for standardization and production engineering in support of procurement.

Our mission is focused primarily on three product areas and include several distinct fields of endeavor, all covered by the AMC/Training and Doctrine Command (TRADOC) Combat Service Support Mission Area Material Plan (CSS MAMP). They are:

AIRDROP AND COMBAT SERVICE SUPPORT

- Advanced Personnel and Cargo Airdrop Systems
- Hardened Shelter Systems
- Tentage and Organizational Equipment Systems

COMBAT CLOTHING AND INDIVIDUAL EQUIPMENT	- Ballistic Protection - Chemical/Biological/Nuclear Protection - Directed Energy Protection - Countersurveillance/Flame Protection - Environmental Protective Clothing - Microclimate Conditioning Equipment - Integrated Protective Clothing
FOOD ENGINEERING AND FOOD SERVICE EQUIPMENT	- Combat Feeding Systems - Operational Rations - Ration Packaging Systems

Our overall program is planned and prioritized in response to the deficiencies in the Training and Doctrine Command Battlefield Development Plan and is fully coordinated with the different combat arms (users). Its execution is effectively managed using a modern management control system to ensure that the individual soldier's needs are accurately identified and expeditiously addressed.

THE SOLDIER MODERNIZATION PLAN (SMP): The SMP describes the development of the "Soldier System" from 1991 to 2006. Its purpose is to provide a comprehensive scheme to modernize the soldier as a battlefield system. The soldier's warfighting capabilities will be maximized by enhancing his lethality, command and control, survivability, sustainment, and mobility. The SMP covers the full range of research, development, and acquisition from technology base to systems development to the fielding of soldier items.

The basic strategy of the SMP is to draw upon the achievements and advances in many areas of technical expertise in the Army, the other services, allies, and industry. This will furnish state-of-the-art technologies which can be integrated into a system which will provide a synergistic improvement in combat effectiveness.

One of the basic precepts in soldier modernization is the realization that while maximum commonality and interchangeability are highly desirable, significant differences exist among various groups of soldiers in terms of the threat they face, their operational environment, the burden they have to carry, and their degree of exposure to the elements. These differences frequently warrant specialized materiel solutions and will be considered by combat and materiel developers throughout the life-cycle management process.

THE SOLDIER AS A SYSTEM: A key recommendation of the SMP is to view and manage the soldier as a system, the Army's primary combat system. In the past, the soldier system items have been developed independently; we need to address the individual soldier in a well-integrated, well-balanced, and systematic manner in order to achieve some measure of overall improved combat effectiveness. The soldier system approach will permit the elevation of soldier system issues and the appropriate integration of components; the main strategy of the SMP is to coordinate and integrate all of these related technology developments. This balanced effort covers technologies for lethality, command & control, survivability, sustainment, and mobility.

TECHNOLOGY BASE EXECUTIVE STEERING COMMITTEE (TBESC): In order to accomplish this well-balanced soldier system research and development effort among independent organizations, the TBESC has been established to coordinate the various technologies necessary for future soldier systems. The members of the TBESC include the TRADOC Systems Manager (TSM) - Soldier, the future Program Manager (PM) - Soldier, NATICK and the Technical Directors or their authorized representatives, of the following organizations:

U.S.Army Armament Research, Development, and Engineering Center (ARDEC)
U.S.Army Research Institute (ARI)
U.S.Army Research Office (ARO)
U.S.Army Belvoir Research, Development, and Engineering Center (BRDEC)
U.S.Army Communications and Electronics Command (CECOM)
U.S.Army Chemical Research, Development, and Engineering Center (CRDEC)
U.S.Army Laboratory Command (LABCOM)
U.S.Army LABCOM Electronics Technology and Devices Laboratory (ETDL)
U.S.Army Harry Diamond Laboratory (HDL)
U.S.Army Human Engineering Laboratory (HEL)
U.S.Army Material Technology Laboratory (MTL)
U.S.Army Medical Research and Development Center (USAMRDC)
U.S.Army Special Operations Command (USSOCOM).

The TBESC oversees the technology base (6.1, 6.2, and 6.3a) for the Future Soldier System. The technology base for the Future Soldier System will include all the technologies for the individual soldier that are under development, or are proposed for development, to accomplish future soldier requirements.

Natick has undertaken the task of treating the soldier as a system, and has initiated many activities in support of this goal. For technology base management duties, Natick: chairs and provides administrative support to the TBESC; chairs the TBESC working group; provides the technology base annex to the Soldier Modernization Plan; coordinates/integrates inputs to the Soldier Modernization section of the Army Technology Base Master Plan; chairs an international technology base leveraging working group; orchestrates Soldier System Technology Area Assessments; and serves as the Soldier System materiel integrator.

APPROACH TO MODERNIZATION: The Soldier Integrated Protective Ensemble (SIPE) Advanced Technology Transition Demonstration (ATTD) is an ongoing program that exemplifies the SMP strategy and soldier system approach to improve combat effectiveness. Although the thrust of this effort is for the dismounted combat soldier, the multitude of diverse technologies will have broad applications for all soldiers. The SIPE ATTD is an example of the soldier system research and development; the most promising high payoff technologies will be exploited in order to engineer a modular head-to-toe fighting system with enhanced warfighting capabilities.

THE BLOCK CONCEPT: Individual soldier technologies required to modernize the five soldier capabilities are developed in several commands within AMC (including the following: Armaments (AMCCOM), Communications and Electronics Command (CECOM), Troop Support Command (TROSCOM), and Missile Command (MICOM) as well as outside of AMC such as the US Army Medical R&D Command (MRDC), Army Corps of Engineers, NATO, National Labs, etc. These technologies must be developed in harmony at the right time for the soldier system to result in an integrated entity. The SMP-proposed use of the block concept will help to ensure the integration of all the components of soldier modernization. The appendix to this document presents the Block I (Next Generation System) proposed for the Soldier System as identified in the Army Technology Base Master Plan (ATBMP): The Enhanced Integrated Soldier System (TEISS).

4. PROGRAM GOALS

Our program goals are to:

Ensure maximum survivability, supportability, sustainability and combat effectiveness of individual soldiers and crews at all times under all environmental conditions.

Be the Center of Excellence for research, development and engineering in combat clothing and individual protective equipment, tactical shelters and tentage, airdrop systems, and organizational equipment.

Achieve major technological and system improvements on highest priority user-relevant programs and expedite fielding of these improvements.

Exploit the worldwide technology base to achieve mission technology superiority.

Plan and conduct technology base programs which support development of Natick's Next Generation/Future Systems (NG/FS) by addressing major technology barriers.

Optimize the use of resources to enhance productivity.

Maintain a cohesive long-range R&D plan and a corporate strategy which achieve and sustain mission superiority.

III. TECHNOLOGY BASE INVESTMENT STRATEGY

Technology is the lifeblood of new and improved Army systems and equipment. However, technology can only be an effective force multiplier if the application is fielded quickly. Streamlined acquisition measures are used by Natick to shorten the time between proving a concept feasible and putting a system in the hands of troops.

Exploiting new technologies to field-effective and affordable systems and equipment for the Army is a challenging process, one that is becoming institutionalized at both AMC and TRADOC through comprehensive analysis and long-range planning. The Army's Long-Range Army Materiel Requirements Plan (LRAMRP) provide the means for articulating a strategy for overcoming battlefield deficiencies and a rational allocation of resources based on criticality of need. The link between mission area strategies and technology base planning is a set of Next Generation and Future Systems (NG/FS).

Natick is the proponent for several NG/FS, including one NG system encompassing the CIE area entitled The Enhanced Integrated Soldier System (TEISS), (described in the Appendix). The applicable FS is entitled The Future Combat Soldier System. NG/FS are generally described in conceptual terms and provide a set of references and targets for technology base efforts needed by focusing on specific critical technological barriers.

Natick's technology base investment strategy is composed of four major elements:

1. NEXT GENERATION AND FUTURE SYSTEMS

Approximately 50 percent of our technology base resources (6.1 basic research, 6.2 exploratory development, and 6.3a proof-of-principle demonstration) is allocated in support of specific Next Generation and Future Systems (NG/FS). NG systems will begin full-scale development in the late 1990s and will provide a fielded capability into the 21st century. For each system, the technological barriers have been identified which could prevent achievement of the capabilities desired. Programs an proof-of-principle demonstrations of prototypes (technology demonstrations) have been structured in a logical, time-phased manner.

2. EMERGING TECHNOLOGIES

The potential of some emerging technologies is so great that it warrants special visibility and management attention, even when its application to a

specific system is unclear. About 20 percent of our technology base's total resources is dedicated to maturing such high-payoff technologies. In the CIE area, our key emerging technologies fall into the biotechnology, advanced materials and processes, neuroscience, and protection/lethality areas.

3. SYSTEMIC PROBLEMS

Chronic problems which face the Army, such as logistics research and development, MANPRINT/human factors engineering, soldier acceptability, lightening the soldier's load, and sizing and tariff of CIE, lend themselves to technological solutions, but often do not have a system focus. About 25 percent of our technology base resources is allocated for these kinds of problems to make sure that they get the attention they require.

4. SUPPORTING CAPABILITIES

Finally, our investment strategy allocates about five percent of resources in support of analytical capabilities. These include front-end analyses, modeling and simulations, Automated Data Processing (ADP) data base development, special-purpose equipment, and other infrastructure items that ensure our continuing ability to execute quality R&D programs and act as smart buyers across the entire spectrum of the materiel life cycle.

IV. CLOTHING AND INDIVIDUAL EQUIPMENT (CIE)

1. OVERVIEW

Natick's CIE technology program is directed toward advanced integrated combat clothing systems. There are five basic climatic environments for which the Army provides clothing systems; hot-wet, hot-dry, temperate, cold-wet and cold-dry. In some geographical areas, seasonal variations in climate necessitate the issue of more than one clothing ensemble. In addition, protection from special hazards or threats requires separate issue of unique items, such as a chemical protective overgarment or a ballistic protective vest.

Applied research efforts in the CIE area have been conducted in a group of separate technology areas supporting CIE development. Emphasis has been, and continues to be, placed on improving individual soldier survivability, reducing the soldier's load, and lessening the logistic burden in the CIE area. Applied research and development efforts in each area are aimed at integrating the technology advances in these areas into a single item or system of clothing or equipment, instead of a large number of separate items. The development of CIE, providing integrated protection in a single item or system at a level meeting Army requirements, is the technological challenge for the next several decades. The CIE technology thrust areas, listed alphabetically, include:

a. Ballistic Protection

b. Chemical/Biological Protection

c. Clothing and Equipment Design and Sizing

d. Countersurveillance Measures

e. Directed Energy Protection

f. Environmental Protective Clothing and Equipment

g. Flame Protection

h. Integrated Protection

i. Material Degradation

j. Microclimate Conditioning

2. PROGRESS AND ACCOMPLISHMENTS

Natick is responsible for many significant Research, Development, Testing, and Evaluation (RDTE) programs. Military relevance, quality products, mission productivity, progressive management initiatives and technical competence are synonymous with our programs, our staff and our achievements. Through engineering for today, development for tomorrow, and research for the future, we are truly providing the decisive edge for the American soldier. We have, for example, focused our tech base programs toward the technologies needed for NG/FS, while still addressing the systemic Army problems, emerging technologies and required supporting capabilities. Examples of our FY91 accomplishments in the CIE area follow.

a. Basic Research Program (6.1): During FY91, our Research Program accomplishments included:

Characterized novel liquid crystal polymers for ballistic protection.

Researched thermoplastic resins for ballistic protection for helmet applications.

Developed generic technology with optoelectronic capabilities for dynamic camouflage.

Characterized liquid crystalline phase of silk proteins for processing improvements.

Identified excellent nonlinear optical properties for enzyme-derived new polymers.

Demonstrated detoxification of G-agents in vapor phase by immobilized microbial enzyme on cotton.

b. Exploratory Development Program (6.2): During FY91, our Exploratory Development Program accomplishments included:

Developed advanced elastomer formulations and produced prototype multipurpose overboots (MULO): Footwear protection has been provided for many years by the butyl chemical protective footwear cover. Recently, the green vinyl overshoe (GVO), made from polyvinyl chloride, replaced the butyl items. The GVO provides adequate protection against chemical warfare agents, but improvements in durability, petroleum/oil/lubricant (POL) resistance, flame resistance, resistance to decontaminating chemicals, and improved traction on various surfaces are desired. No single material is currently available to satisfy all these requirements. A MULO incorporating polymer blends to meet the additional performance goals is now under development.

Directly transferred new, three-color desert camouflage pattern to end item development: The new, three-color desert camouflage was developed to provide more effective countersurveillance protection than the standard six-color pattern in a desert terrain. Based upon its improved camouflage effectiveness, the US Army Infantry School selected and approved the three-color pattern as the new standard to enhance soldier protection in Southwest Asia during Oct 90. Specification changes were immediately made to include the new pattern in the Desert Battle Dress Uniform, the Hot Weather Battle Dress Uniform, and Field Coat Specifications.

Produced carbon-loaded semipermeable membranes for the US MARINE CORPS Advanced Technology Demonstration (ATD): The 3M Co. has a basic Empore™ technology for narrow width microporous polytetrafluoroethylene membranes. These membranes are loaded with various sorptive materials, and marketed for use in chemical analysis. In conjunction with 3M, the Empore technology was exploited to develop sorbent semipermeable membranes loaded with supersorbent active carbon. Membrane laminates were evaluated for use in chemical protective uniforms. These laminates should offer extended protection against agent liquids, aerosols, and vapors; are waterproof; and allow comfort based on evaporative cooling. Wider-width (36-inch) production capability of the membranes was successfully scaled up to pilot plant level.

Transferred reduced weight Spectra & Improved Kevlar fabric-based helmet technology.

The current standard PASGT helmet is a fiber-reinforced composite molded of Kevlar fabric impregnated with a polyvinyl butyral-phenol formaldehyde resin. By taking advantage of improved fiber technology, Natick, in conjunction with U.S. Army Materials Technology Laboratory and industry, developed the technology for a reduced weight PASGT helmet (15% lighter), which has been transferred to the Soldier Enhancement Program. The helmet configuration has not changed; helmets were produced utilizing, to the greatest extent possible, current tooling, design, and manufacturing techniques with the new lightweight composite materials.

Prepared lightweight helmets using unidirectional SPECTRA SHIELD: During the late 1980s, Allied-Signal Inc. patented a new composite technology consisting of a fibrous nonwoven-type material with polymer-impregnated Spectra fibers formed into a unidirectional web, now known as Spectra Shield[R]. Research has focused on transferring the flat panel Spectra Shield[R] weight reduction potential into helmet semi-spherical shapes. A number of important advances have occurred, including: 1) the development of improved resin systems; 2) the development of an automated manufacturing process; 3) and the demonstration of helmet shells molded from Spectra Shield.

Provided ballistic/laser eye protection, fixed line and blocking filter for the individual soldier: Protection provided includes the following: 1) fixed line - three line protection using dye technology on the sun, wind, and dust (SWD) goggle; 2) blocking filter - filter blocking blue region of the spectrum and/or near IR region; 3) and blocking filter - Either reflective (dielectric stacks) or absorbing (dyes) or a combination of both.

c. Proof of Principle Program (6.3a): Soldier Integrated Protective Ensemble (SIPE) Advanced Technology Transition Demonstration (ATTD)

SIPE is a modular head-to-toe fighting system designed to balance mission performance and protection by viewing the soldier as a total system.

During FY91, our program accomplishments included:

Delivery of Phase I "Breadboard" hardware and conducted Phase I evaluations:

Natick Phase I evaluations:

- Field-of-view,
- Manual dexterity,
- Speech intelligibility,
- Maneuverability,
- Mobility,
- Compatibility,
- Fit test.

Other Government Agency (OGA) Phase I Evaluations:

- US Army Communications and Electronics Command (CECOM), compatibility with computer, daytime viewing/graphics display.
- CECOM Center for Night Vision and Electro-Optics (C2NVEO), low light level vs. resolution, distortion/field-of-view, night walking/driving/firing.
- US Army Human Engineering Laboratory (HEL), human factors/compatibility, hearing and communications, mobility, M16 rifle compatibility.

Initiation of Phase II hardware development.

Initiation of detailed development of scenario for field operational demonstration.

Initiation of modeling effort with the Institute for Defense Analysis (IDA), to run initial force-on-force gaming at the infantry squad level.

Conducted planning for follow-on efforts to facilitate technology build (FY93 Transition year efforts and follow-on "CREW SIPE" and "AIRCREW SIPE" ATTD Programs).

d. Advanced and Engineering Development Programs (6.3b and 6.4): During FY91, our development program accomplishments included:

Desert Battledress Uniform (DBDU): To respond to urgent and immediate Operation Desert Storm needs, the weight of the DBDU was reduced through removal of the internal yoke and elbow, seat, and knee patches. Additionally, Natick further improved the camouflage performance of the uniform by introducing a new, three-color camouflage pattern. This new pattern is easier and faster to print. It also provides improved camouflage protection against detection by visual means and image intensification devices. Under a Soldier Enhancement Program, initiated in FY90, further improvements to uniform weight, comfort, and appearance were implemented through experimental synthetic blend fabrics and numerous uniform design changes. Technical and operational testing, and identification and approval of suitable uniform enhancements will be completed in FY92.

Desert Boot: Development has been successfully completed and a boot for desert environments has been adopted as a standard item. The boot will significantly improve the performance of the individual soldier in a hot, dry environment. Some critical boot features include: insulated mid-sole, ankle support, comfort collar and lining, low-density rubber compound sole, speed lacing and contoured-cushion sole. Prior to the development, no standard boot existed which provided the protection required. Commercially available items were considered, but were found lacking in all required design features.

Laser Eye Protection for Soldiers: Development has been successfully completed on several laser eye protective devices for combat soldiers. These devices will significantly improve the safety of the individual soldier in a laser-hazardous battlefield. The two wavelength protective capability of the Ballistic Laser Protective Spectacle (BLPS) was added to the existing protective capabilities of the Goggles, Sun, Wind, and Dust (SWD), and the Visor, Flyers' Helmet. Also, a three wavelength protective capability was developed for the Goggles and the Visor, and can be used for protection from sunlight and glare during daytime operations. All three laser-protective devices (BLPS, Goggles, and Visors), were fielded to the appropriate troops during Operation Desert Storm. Technology base efforts are being pursued with reflective and hybrid technologies to optimize photopic/scotopic transmittance and laser protection for future eyewear applications.

Toxicological Agents Protective (TAP) Suit Cooling System: Integration of a commercial cooling system, the Life Support System Inc. (LSSI), with the M3 TAP Suit was successfully completed to support Explosive Ordnance Disposal (EOD) personnel during ODS. In addition, prototype cooling systems specifically designed to be integrated with the TAP Suit and/or the Self-Contained, Toxic Environment Protective Outfit - Interim (STEPO-I) were developed and demonstrated to the depot/EOD user community. The new TAP Suit/STEPO-I cooling system is more efficient, lighter weight, and less expensive than the commercial system used during ODS. A requirements document was developed for this venture at the end of FY91.

Microclimate Conditioning (MCC): Significant advances in the area of microclimate cooling have been achieved in FY91. Under the Individual Microclimate Cooling System (IMCS) and STEPO programs, the components of the vapor compression cycle have been appropriately miniaturized and configured for optimum performance. A battery-driven cooling system has been designed for use in oxygen deficient environments for STEPO. The system weighs 23.5 pounds (including 9.5 pounds of batteries) and has been successfully demonstrated at several user locations. A second generation STEPO cooling system is currently being fabricated and is expected to weigh approximately 36 percent less and achieve a 33 percent volume reduction over the first prototype. This system will weigh approximately 10 pounds less than the maximum allowable weight of 25 pounds, as specified in the requirement document, while maintaining the required cooling capacity of 300 watts for four hours. The IMCS program has built upon these successes and is well on the way to producing an engine-driven system weighing approximately 17 pounds, while providing 300 watts of continuous cooling for six hours.

4. PLANNED PROGRAM

With increased fiscal restraints, it is imperative that our research, technology and development program efforts be prioritized to maximize our gains for the individual soldier. To that end, therefore, our planned programs for fiscal years 1992-1994 will be focused on priority areas, and our major objectives include:

a. FY92-94 Basic Research Program (6.1)

Includes plans to:

Synthesize/characterize graft copolymers and liquid crystal polymers for ballistic application.

Develop efficient nonlinear optical polymers for laser eye protection.

Model monolayers for membranes, ceramics, and signature reduction assemblies.

Characterize new protein-based selective barrier membranes for chemical and biological protection.

Characterize recombinant silk proteins in new production systems.

Characterize/model bioengineered protein-based elastomers.

Apply solid state Nuclear Magnetic Resonance (NMR) methods to determine diffusion kinetics in selected elastomers

FOCAL POINT FOR RESEARCH PROGRAM: Dr. Abner S. Salant
Telephone: 508-651-4577

b. FY92-94 Exploratory Development Program (6.2)

Includes plans to:

BALLISTIC PROTECTION:

Investigate/develop novel semi-flexible composite structures for personnel armor ballistic protection.

Investigate/characterize novel all-thermoplastic resin matrices for ballistic protection in helmets.

Investigate state-of-the-art lightweight composite materials for application to microclimate conditioning systems.

Explore unique fabric geometries/molding concepts for helmet composites (e.g. filament-winding, resin-transfer molding, metal matrix composites).

Develop mathematical model to describe casualty effects of flechettes projectiles.

BEHAVIORAL/PERFORMANCE TECHNOLOGY:

Construct cognitive, mood, sensory-motor test battery to evaluate soldier system effectiveness.

Assess encumbrance of human motion by CIE.

Determine effects of clothing on anthropometry and range of motion for input into JACK model.

Incorporate advanced CIE design features and visual field and strength data into soldier CAD model.

Evaluate ethnic/cultural impact on soldier system.

CHEMICAL/BIOLOGICAL PROTECTION:

Develop/characterize lightweight multilayer materials for advanced barrier materials.

Complete process scale-up of loaded waterproof/breathable membranes for chemical protection and transfer materials to USMC Advanced Technology Demonstration.

Transfer dry-cleaning solvent, which will serve as a general field laundry cleaning solvent and will decontaminate chemical agents from clothing, to the Laundry and Dry Cleaning Solvent (LADDS) program.

Utilize Empore technology to prepare and optimize microporous PTFE membranes loaded with supersorbent active carbon and produce fabric laminates which provide liquid, vapor, and aerosol agent protection.

Determine optimized fabric constructions for increased aerosol penetration resistance. Explore novel technologies for developing a chemical agent vapor protective fabric based on activated carbon fiber technology.

Study water interactions and transport in hydrophilic polymers.

Develop commercial source and optimize application of superadsorbent carbon.

Evaluate thermoplastic elastomers for barrier applications (TAP Suit, gloves, boots) and transfer to end item development.

COUNTERSURVEILLANCE/CAMOUFLAGE:

Develop cold-regions multi-terrain camouflage fabrics.

Provide colorant information to counter effects of laser-induced luminescence.

Develop reversible fabrics combining thermal imaging protection and camouflage capabilities.

Transfer optimal urban camouflage materials to end item development.

Provide combat soldier identifiers for CIE.

Investigate novel pigments/colorants to reduce thermal emission, improve nuclear thermal flash protection, and to produce adaptive camouflage.

DIRECTED ENERGY PROTECTION:

Develop computer aided design (CAD) program for 3D graphics/analysis of thermal transfer.

Develop/construct bench scale apparatus to measure thermal transfer for incendiary weapons effects.

Construct and test improved instrumented manikin for use in evaluating thermal transfer in clothing items.

Provide a comprehensive data base for the attenuation of non-optical radiation through personnel protective items.

INTEGRATED/ENVIRONMENTAL PROTECTION:

Investigate novel, low-power microclimate cooling technologies.

Develop lightweight shell fabrics for integrated protection.

Investigate the potential of heated handwear to provide the individual soldier with thermal protection in arctic environments.

Develop an integrated soldier performance model to support front end analyses of soldier system items.

Develop a battlefield laser model to support the design of protective equipment through stochastic model results.

Develop algorithms to integrate the stochastic process of existing casualty estimation/assessment programs with individual performance models.

Develop flame resistant, high efficiency, thermal insulation battings for cold weather protection.

FOCAL POINT FOR DIRECTED ENERGY AND BEHAVIORAL/PERFORMANCE:
Dr. Abner Salant
Telephone: 508 651-4577

FOCAL POINT FOR ALL OTHER AREAS:
Mr. Maurice Denommee
Telephone: 508-651-4447

c. FY92-93 Proof-of-Principle Program (6.3a)
SOLDIER INTEGRATED PROTECTIVE ENSEMBLE (SIPE)

Includes plans to:
Fabricate brassboard hardware for field demonstration.

Execute squad-level troop demonstration at Ft. Benning.

Conduct physiological evaluation.

FY93 Transition year efforts:
System integration, electronics optimization, definition of individual power focus, human performance issues, and technology insertions.

Transfer of SIPE to full scale development (FSD) of The Enhanced Integrated Soldier System (TEISS).

FOCAL POINT FOR SIPE PROGRAM: Ms. Carol Fitzgerald
Telephone: 508-651-5436

d. FY92-94 Advanced and Engineering Development Program (6.3b/6.4)
Includes plans to:

Continue analysis of foreign chemical protective clothing and equipment items.

Pursue short-term development utilizing/modifying commercial items in a multitude of CIE to enhance dismounted infantry combat effectiveness under the Soldier Enhancement Program.

LIFE SUPPORT CLOTHING:
Initiate development of combat vehicle crewmember (CVC)/aircrew footwear.

Initiate development of personal camouflage for urban areas.

Initiate development of multi-terrain camouflage uniform.

Initiate development of petroleum/oil/lubricant (POL) resistant chemical/biological tactile glove.

Develop microclimate cooling air vest for the aviator.

Continue advanced development of Multipurpose Overboot (MULO).

Complete development of interim Self-Contained Toxic Environment Protective Outfit (STEPO); continue development of final outfit.

Complete development of Aircrew Uniform Integrated Battlefield (AUIB) P3I packaging.

Complete development of AUIB undergarment. (This will be known as Vapor Protective Flame Resistant Undergarment (VPFRU)).

Complete development of AUIB P3I Outergarment.

Complete development of Special Purpose TAP Hood.

Optimize Multiple Threat Body Armor (MTBA) vest.

Complete development of Aircrew Clothing System, Cold Weather (ACSCW).

Complete development of Body Armor System, Individual Countermine (BASIC).

Complete development of Intermediate Cold Wet Glove (ICWG)

LIFE SUPPORT EQUIPMENT:

Initiate development of lightweight energy-absorbing cargo frame.

Initiate development of advanced ballistic/laser eye armor.

Initiate development of Mask Drinking System - final.

Complete development of TAP Suit microclimate cooling system.

Complete development of auxiliary aviation lighting devices.

Complete development of STEPO cooling system.

Continue development of Individual Microclimate Cooling System for dismounted soldiers.

Complete development of laser/ballistic non-prescription cylindrical system (SPECS)

Complete development of laser/ballistic toric eyewear. Implement product improvements.

Complete development of Soldier's Ground Insulator (SGI)

Complete development of Mask Drinking System - Interim (MDS-I)

Complete development of Combat Soldier Sleeping System (CSSS)

Complete development of Communications/Aural Protective System (CAPS)

Complete development of Artillery Communications/Aural Protective System (ACAPS)

Complete development of Ballistic/Laser Sun, Wind, and Dust Goggles (BLSWDG)

Complete development of Mattax

FOCAL POINT FOR PROGRAM: Mr. Charles R. Williams
Telephone: 508-651-4120

5. MAJOR TECHNOLOGICAL BARRIERS

The major technological barriers that must be overcome to achieve near- to mid-term CIE Program objectives include:

a. CHEMICAL/BIOLOGICAL PROTECTION FOR INDIVIDUALS: The protection of the soldier from exposure to hazardous chemicals, such as warfare agents, is essential to mission accomplishments on today's battlefield and that of the future. This protection is currently accomplished through the use of an activated carbon system, the use of semi-permeable material systems, and the use of impermeable barrier materials. The activated carbon system is used in protective overgarments and affords protection by absorbing hazardous chemicals.

The impermeable barrier materials consist of rubber and coated fabrics found in gloves, boots, and some ensembles, which afford protection by acting as a physical barrier to chemicals. In the future, chemical protective uniforms will need to provide protection against multiple threats including toxic aerosols and biological agents, be decontaminable, and be reusable. These uniforms must also be comfortable in all climates and not impair the mobility or performance of the soldier. The materials for these uniforms should be lightweight, have improved protection, have increased durability and shelf life, and be reusable through the use of reactive materials which will detoxify the CW agents. There is a need for the development of methods for measuring

adsorption of agents and agent surrogates within protective materials and for determining the reaction products (quantitative and qualitative) that originate from detoxification chemistry taking place in catalytic and reactive materials.

Technical POCs: Mr. Maurice Denommee	Mr. Thomas Pease
Telephone: 508-651-4447	Telephone: 508-651-4926

b. BALLISTIC PROTECTION FOR INDIVIDUALS: Ballistic protection for the individual soldier involves protection of the body and the eye against a variety of projectiles which differ widely in shape, size, and impacting velocity. New materials are required to meet these broad ballistic threats and to lighten the load carried by the soldier. In addition, eye protection from a ballistic threat requires light transparent materials for eyewear with improvements in ballistic penetration, scratch resistance, optical clarity, and the ability to be integrated into laser eye concepts.

Technical POCs: Dr. Frank Bissett	Mr. Gary Olejniczak
Telephone: 508-651-4585	Telephone: 508-651-4046

c. COUNTERSURVEILLANCE: Survivability is fundamental to the conduct of warfare. The countersurveillance mission is to enhance the survivability of the soldier by providing textiles for uniforms, individual equipment, and tentage that reduce visibility to various sensor threats (image intensifiers, radar, thermal imagers, and multi-spectral sensors) to background level. Countersurveillance activities center on the R&D of unique dyes/pigments, additives and coatings for textiles to achieve signature suppression.

Technical POC: Ms. Therese R. Commerford
Telephone: 508-651-5469

d. COMBAT SOLDIER CLOTHING AND INDIVIDUAL EQUIPMENT (CIE) IDENTIFIER: Incidents of fratricide on the battlefield have historically plagued deployed forces in operational conflicts. The resolution of night-vision devices and image intensifiers is not always good enough to distinguish friend from foe. There have been some industry developments in the areas of passive, active (i.e. laser detection and light-emitting diodes) and a combined passive/active to attain degrees of individual soldier recognition.

Technical POC: Ms. Therese R. Commerford
Telephone: 508-651-5469

e. INDIVIDUAL PROTECTION AGAINST DIRECTED ENERGY WEAPONS (DEW) LASER EYE PROTECTION: From the point-of-view of the individual combat soldier, the low-energy lasers currently found on the battlefield as range finders and target designators represent the most imminent danger from directed energy. In

the very near future, the ready availability of tunable, or agile, lasers will offer the potential for an even more serious threat to the eyes of individuals.

Protection against the fixed-frequency lasers has been shown to be attainable by the use of dye absorbers and Bragg reflectors, such as holograms. These systems have been used in combination with a polycarbonate substrate to produce devices that provide soldiers with the required level of ballistic protection and fixed-frequency transmittance. Poor durability and high cost are still to be overcome.

Against the future battlefield hazards that will be created by tunable lasers, no technology investigated thus far has shown significant promise for use by the foot soldier. Stringent weight and bulk limitations, added to the intrinsic requirements of response time, broadband response, and high visual transmittance, make this problem a formidable one.

Technical POC: Dr. Frank Bissett
Telephone: 508-651-4588

f. MICROCLIMATE COOLING FOR THE INDIVIDUAL SOLDIER: Microclimate cooling (MCC) equipment (or other means) is essential to eliminate heat stress in infantry personnel and Combat Vehicle personnel (air and ground) who are required to perform their combat mission while operating in elevated ambient temperatures and wearing chemical protective garments. Much progress has been made in the area of MCC equipment for Combat Vehicle Crewmen (CVC), and an extensive, ongoing advanced development effort is addressing requirements for both CVC onboard vehicle operations and CVC operating in a dismounted mode. Additional technology base work needs to be accomplished before advanced development can begin to address the microclimate requirements of infantry personnel for a truly man-portable system. MCC for the individual soldier can be divided into the following components: lightweight power; lightweight hermetic compressors; and lightweight cooling vests.

Technical POC: Mr. Wesley Goodwin
Telephone: 508-651-4418

g. FLAME PROTECTION: There is a need for uniforms which will provide integrated protection from flame and nuclear thermal threats, but will not impair the comfort or mobility of the soldier. Future uniform materials should also be cleanable through dry cleaning or aqueous laundry techniques, and durable for long field use. Areas of interest include: novel concepts for fiber composition and fabric structure for shell materials which provide maximum durability, fire retardancy, and nuclear thermal protection, while reducing the overall weight of the uniform; and advanced technology and novel concepts related to flame-retardant rubber gloves, boots, and coated fabric materials for use in chemical-protective clothing ensembles.

Technical POC: Mr. Maurice Denommee
Telephone: 508-651-4447

h. SURFACE HEATING ELEMENTS: There is a need to provide better extreme cold weather protection for the hands and feet of soldiers. There is also a need to improve the visibility of soldiers wearing protective face shields in both cold and hot, humid environments. One means of accomplishing these improvements would be through the generation of advanced technology in the surface heating elements area. Areas of interest include: new materials which are electrically conductive, thin, flexible, and durable, and related exploratory development efforts through which the feasibility of using such new materials in electrically-heated handwear may be demonstrated, including dexterity and tactility features; and also using these materials on or integrated into a protective face shield for improved visibility in both cold and hot-humid environments.

Technical POC: Mr. Wesley Goodwin
Telephone: 508-651-4418

i. BIOENGINEERED MATERIALS: Materials produced or modified through the activities of biological systems and which represent the application of biotechnology to the material sciences. Materials with enhanced performance or novel capabilities are sought which may include, but are not limited to, high performance fibers for ballistic protection and composite structures, reactive finishes for chemical/biological warfare defense, photodynamic pigments for camouflage, elastomers, nonlinear optical polymers for directed energy protection, films/coatings, and ceramics.

Technical POC: Dr. David Kaplan
Telephone: 508-651-5525

j. TEXTILE TECHNOLOGY CENTER: Textile Technology Center sources are sought among institutions of higher learning with undergraduate and graduate level study programs lending themselves to the establishment of a Center. The programs must relate to protection of the individual soldier against battlefield threats such as ballistic, chemical, biological, fire, thermal, and directed energy, while ensuring survival under extremes of environmental (temperature and humidity) conditions by involving comprehensive research and engineering in the following areas:

Polymer synthesis and characterization.
Fiber morphology and mechanical-property characterization.
High-strength fibers (i.e., fibers from liquid crystal polymers).
Yarn and fabric manufacturing and fabric preparation and finishing processes.
Photochemistry and photophysics of dyes and dyed textiles.
Methods for sorbing/reacting chemical warfare agents in lightweight, low-heat stress textile systems.

Producibility of unique fibers and fabrics.
Thermally resistant insulating textile systems.

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The major technological barriers that must be overcome to achieve mid- to long-term CIE Program objectives are indicated in the APPENDIX.

6. PROGRAM RELATIONSHIPS AND INTERACTIONS

a. Natick has significant interaction with the other seven AMC RD&E centers and with most of the LABCOM Corporate Laboratories. Some of the cooperative efforts are included below:

U.S. Army Belvoir RD&E Center on lightweight power sources and camouflage development;
-TBESC Individual Power Working Group.

U.S. Army Communications and Electronics Command (CECOM) for communications and individual soldier computer;

CECOM Center for Night Vision and Electro Imagers/Optics for night vision and imagers/sensors;

Electronics Technology and Devices Laboratory for batteries and flat panel displays;

U.S. Army Armament RD&E Center for individual soldier weapon, holsters, and ammunition pouches;

Program Manager-Aviation Life Support Equipment;

U.S. Army Tank-Automotive RD&E Center for microclimate conditioning interface information;

U.S. Army Chemical RD&E Center for: CB test methodologies; CB agent testing services and initial data assessments; and the development of agent surrogates for chemical agents.

U.S. Army Missile RD&E Center on special ballistic protective items;

U.S. Army Ballistic Research Laboratory for information on microwave protection, ballistic models, ballistic testing and casualty reduction analysis applicable to the individual soldier;

U.S. Army Human Engineering Laboratory on anthropometry support, clothing, human engineering factors, human performance testing, test bed for Lightening the Soldier's Load and human factors;

U.S. Army Harry Diamond Laboratory on nuclear effects testing and nuclear evaluation data;

U.S. Army Materials Technology Laboratory on material technology and modeling of materials, ceramics, elastomers, metals, composites and transparent ballistic materials, ballistic firings, chemical permeation, and laser materials. Cooperative efforts also include the application of materials modeling for the individual soldier, fiber and textile materials technology, elastomer compounding service, information on spectrometric tests, wet chemistry, materials/lasers, microbial protection for materials, and weathering;

TBESC Soldier System Architecture Working Group;
TBESC Soldier System Marketing Working Group;
TBESC Soldier System International Working Group.

b. Natick also interacts with the Office of The Surgeon General on heat stress information and testing for chemical-protective clothing, human performance modeling, and soldier's load information.

c. Natick interacts with other Services, other government agencies and foreign governments to meet technology needs. Examples of these types of interactions are:

U.S. Air Force - High performance polymer technology, life support technology for aviator, and chemical defense models;

U.S. Navy, U.S. Air Force and U.S. Marine Corps - Multi-Service chemical defense program;

U.S. Marine Corps - Research, development, testing, and evaluation reimbursable orders;

Other DoD - clothing manufacturing technology; engineering support to DPSC for clothing and individual equipment;

Foreign-technology data exchanges, International Materiel Evaluations (IME), and system alternatives. NATO, ABCA, and DEA information/item exchanges; also procurement of clothing for Saudi Arabian troops.

Other Government Agencies - Ballistic eye protection work, Postal Service work.

d. Our interactions with Industry and market surveillance are ongoing processes which are enhanced by the active participation of our official Natick representatives to 115 nongovernmental technical committees, and the active membership of Natick employees in national scientific and technical associations/societies such as:

ACS, AIC, AIChE, ANS, APA, APS, ASME, IFT, ORSA, SAME, AATT, AIAA, APHA, ASM, RSC, SAMPE, SPE, AATCC, ASTM, and Sigma Xi.

In addition, we formally interact with Industry during several key events in the R&D life cycle, e.g., at the time of formulation of the requirement document, when conducting a market analysis, during the preparation of specifications and standards, and the preparation of standardization program analyses/plans.

We are also active participants in the Independent R&D Program, the Army Information for Industry Program (including the Army Potential Contractor Program, the use of Broad Agency Announcements and Advance Planning Briefings for Industry), the Unsolicited Proposals Program and the Small Business Innovative Research Program.

The Army Domestic Technology Transfer Program seeks to promote the transfer of Army technology and expertise to the private sector, so that the technology can be exploited for improving U.S. competitiveness. One mechanism for such transfers is the use of Cooperative R&D Agreements (CRDAs) between Army R&D activities and U.S. industry. The CRDA is a contract to cooperate and share intellectual property resulting from joint efforts; work under the CRDA can be exclusively exploited by the company for commercial uses, while the government retains a license to use the technology for its own purposes.

e. We use the technical expertise available in the academic community. We are strong supporters of the Polymer Science activities, under the auspices of the Massachusetts Centers of Excellence. Natick is a member of the Northeastern University Cooperative Research Center for Electromagnetic Research (for laser protection programs), and is in the process of establishing a Textile Technology Center within academia.

f. We also interface with the various TRADOC schools, e.g., the Infantry School (TSM-Soldier), on soldiers' needs and requirements early-on, and maintain close coordination throughout the development process. Once we enter the advanced development and engineering development phases, our funding and program guidance is furnished by the Project Manager for Clothing and Individual Equipment (PM-CIE). We have also established an interface with FORSCOM units to continuously obtain user feedback for our fielded items to make field-worthy improvements.

This document reports research undertaken at the US Army Natick Research, Development and Engineering Center and has been assigned No. NATICK/TR-92/003 in the series of reports approved for publication.

APPENDIX

THE ENHANCED INTEGRATED
SOLDIER SYSTEM

(TEISS)

NG TITLE: THE ENHANCED INTEGRATED SOLDIER SYSTEM (TEISS)

	6.3b	FY94-96
	6.4	FY97-98
DESCRIPTION:	Production	FY99--

TEISS is a modular head-to-toe fighting system designed to balance mission performance and protection by viewing the soldier as a total system. TEISS will transfer those technologies and capabilities successfully demonstrated in the Soldier Integrated Protective Ensemble (SIPE) Advanced Technology Transition Demonstration (ATTD), into full scale development (FSD). The system design will optimize the combat effectiveness of the individual ground soldier by balancing protection against multiple battlefield hazards, with enhanced operation capabilities via the integration of state-of-the-art technologies. The benefits of this integrated, modular approach will offer the soldier new capabilities resulting from the simultaneous use of components which currently cannot be combined: reduced bulk and weight; and improved survivability. TEISS poses very challenging objectives, and success will rely on optimization of state-of-the-art emerging technologies.

MAJOR COMPONENTS:

The major components of the TEISS for the individual ground soldier are:

Advanced Clothing Subsystem consists of an Integrated Combat Uniform (ICU), handwear, footwear and load-carrying equipment providing multiple-threat protection, including ballistic, chemical/biological, flame/thermal, directed energy (DEW), environmental, and surveillance.

Integrated Headgear Subsystem providing a communications capability, ballistic, laser/eye, respiratory and acoustic protection, and a heads-up display for integrated night vision, weapons fire control and individual soldier computer output.

Microclimate Conditioning Subsystem providing a means for soldiers to maintain their thermal equilibrium.

Individual Soldier Computer providing man-portable integrated capabilities such as global positioning, communications, message management, fire control, medical monitoring, expert systems and training.

Objective Family of Small Arms will provide a new individual weapon integral to the TEISS development program.

REMARKS:

TEISS is a joint effort involving the US Army Infantry School and the participation of key Army Materiel Command (AMC) laboratories and centers, including:

U.S. Army Natick Research, Development and Engineering Center (Natick)
U.S. Army Communications and Electronics Command (CECOM)
U.S. Army CECOM Center for Night Vision and Electro-Optics (C2NVEO)
U.S. Army Armament Research, Development and Engineering Center (ARDEC)
U.S. Army Chemical Research, Development and Engineering Center (CRDEC)
U.S. Army Human Engineering Laboratory (HEL)
U.S. Army LABCOM Electronics Technology and Devices Laboratory (ETDL)
U.S. Army LABCOM Harry Diamond Laboratory (HDL)
U.S. Army Ballistics Research Laboratory (BRL)
TRADOC System Manager-Soldier (TSM-Soldier)
U.S. Army Materiel Command PM-Soldier

STATUS: Funding to support development efforts and testing is scheduled to start in FY94.

NOTE: Additional information regarding the major components of TEISS to be developed at Natick can be found on the following data sheets.

Technical POCs for TEISS :	Mr. Charles Williams	Ms. Deirdre Rapacz
	Telephone: 508-651-4447	508-651-5358

ADVANCED CLOTHING SUBSYSTEM

Technical POC for Advanced Clothing Subsystem: Ms. Deirdre Rapacz
Telephone: 508-651-5838

The components of the Advanced Clothing Subsystem are described below:

A. INTEGRATED COMBAT UNIFORM (ICU):

The ICU will provide balanced protection against chemical, flame, environmental, ballistic and DEW threats on the integrated battlefield. The uniform will also demonstrate an overall reduction in weight and bulk over the combined systems currently used to afford this protection. There will be a significant improvement in the mobility, comfort and acceptability of the system. The use of replaceable, launderable and reuseable components will diminish the impact on the logistical support system.

B. INTEGRATED LIGHTWEIGHT COMBAT BOOT (ILBC):

The lightweight combat boot will integrate protection from chemical and environmental threats, while still ensuring comfort and the necessary traction. The boot will partially or completely eliminate the need for chemical protective overboots, depending on the degree of protection capabilities. The boot will be designed for the temperate and desert environments, accommodate easy donning and doffing, and enhance protection with flame-retardant materials applications.

C. ADVANCED HANDWEAR:

This handwear will be designed to incorporate protection from chemical threats into a lightweight glove constructed of high-performance materials and design. The handwear will enhance battlefield efficiency by providing a high degree of durability, while maintaining the dexterity required to operate hand weapons and battlefield instrumentation.

D. ADVANCED MODULAR BODY ARMOR

These systems will consist of optimized state-of-the-art materials applied in a highly refined system design to provide both ballistic and blast overpressure protection. Base modules will protect close combat support troops with module upgrades from 9mm handgun protection to higher threats. Additional features include modules for armor piercing mine and explosive ordnance disposal protection from high-velocity fragments and extreme levels of blast overpressure.

INTEGRATED PROTECTIVE LOAD-BEARING MODULE

This module is a load-bearing system designed to accommodate the power, communications, microclimate conditioning, and climbing/extraction requirements of the future infantry soldier. The design will utilize advanced lightweight, durable, and impact-resistant materials to construct the load-carrying infrastructure optimizing load weight distribution to enhance mobility and minimize energy expenditure.

TECHNICAL BARRIERS TO THE ADVANCED CLOTHING SUBSYSTEM:

Improved lightweight ballistic materials to provide increased protection from fragments and flechettes, with a reduction in weight and bulk.

Improved chemical-protective materials, increased protection, durability and shelf-life with reduced weight, bulk and heat stress.

Improved camouflage materials and systems to reduce signature and thwart detection by emerging multi-spectral surveillance devices.

Protection against directed-energy weapons (DEW), improved protection from evolving laser and high-powered microwave weapons.

System design to efficiently integrate protection/operational capabilities, waste management features, weight reduction.

Launderability/decontaminability, extended-wear life.

Human factors considerations including minimal degradation of normal functions and optimization of operational effectiveness.

Apply biomechanics to minimize CIE encumbrances and enhance mobility by optimizing the soldier-CIE interface.

Quantify relative importance of each hazard and estimate levels of protection required to establish balanced protection.

ADVANCED HEADGEAR SUBSYSTEM

Technical POC for the Advanced Headgear Subsystem: Mr. Stanley Waclawik
Telephone: 508-651-5447

DESCRIPTION:
The improved ground soldier helmet and facial protective system will decrease casualties by providing protection from fragmenting munitions and laser weapons for critical body parts. Additional eye protection will be provided against

the hazard/threat to soldiers' eyes posed by laser range finders (LRFS). The system will be compatible with all clothing and individual equipment, provide interactive functions with weapons, sighting and communication devices, and contribute to the efficient operation of the soldier's overall mission.

TECHNICAL BARRIERS TO THE ADVANCED HEADGEAR SUBSYSTEM

Improved lightweight ballistic materials to provide increased protection from fragments and flechettes, with a reduction in weight.

Improved ballistic protection to the eyes.

Protection against directed energy weapons (DEW) and evolving laser threats.

Improved visual transmittance and durability.

Miniaturization/configuration of electronics.

System design that accommodates the interaction of components tailored to specific mission/threat conditions.

Human factors considerations, minimal degradation of normal functions to optimize operational effectiveness.

MICROCLIMATE CONDITIONING SUBSYSTEM

Technical POC for Microclimate Conditioning: Mr. Wesley Goodwin
Telephone: 508-651-4418

DESCRIPTION:
This modular component of TEISS will be a portable unit that provides cooling and power to the individual soldier. By reducing heat stress, the soldier will perform more effectively in hot environments and/or in chemical protective clothing. The need for restrictive work/rest cycles will be reduced and the mission duration increased. As an integrated component of TEISS the Microclimate Conditioning Subsystem will also provide power to the electronic components of the system.

TECHNICAL BARRIERS TO THE MICROCLIMATE CONDITIONING SUBSYSTEM

System design of long-lasting, lightweight power sources that minimize weight/bulk, and use advanced heat exchange technology and component miniaturization.

Manufacturing process that is unit cost effective.

Human factors considerations including man-machine interface, integration with Clothing and Headgear Subsystems, optimization of maneuverability.

Advanced materials to reduce signature and minimize detection by emerging multi-spectral surveillance devices.